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Research Article

DESIGN AND DEVELOPMENT OF FLOATING TABLETS OF RANITIDINE HYDROCHLORIDE BY USING NATURAL POLYMERS

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Received: 25 January 2017**Accepted:** 10 February 2017**Published:** 28 February 2017**Abstract:**

The aim of present research work is to formulate and evaluate controlled release floating tablet of Ranitidine hydrochloride in view to enhance bioavailability and therapeutic action. The tablets were formulated by employing wet granulation method using PVP K 30 as binder and isopropyl alcohol as granulating fluid. The granules were evaluated for flow properties. All the formulations showed values within the prescribed limits for tests like hardness, friability and weight variation which indicate that the prepared tablets are of standard quality. All the tablets were formulated using sodium bicarbonate as effervescent agent. All the prepared formulations floated immediately after placing into the beaker and the floating was maintained more than 14 hrs. It was observed that the carbon dioxide generated from sodium bicarbonate in presence of dissolution medium (0.1N HCL) was trapped in the polymer gel matrix formed by the hydration of polymer which decreases the density (<1) and makes the tablet buoyant. The correlation coefficient values (r) revealed that the dissolution profiles followed Zero order kinetics and the mechanism of drug release was governed by Peppas model. The n values are found to be more than 0.5 (n>0.5) indicated that the drug release was predominantly controlled by non fickian diffusion. Based on the release rate constant and % of drug release the formulations prepared with Cashew nut tree gum shown prolonged retarding nature compared with the formulations prepared with Aegle marmelos gum. Among all the formulations, F₃ formulation containing drug and Cashew nut tree gum in 1:1.5 ratio was found to be optimized formulations.

Key words: Ranitidine hydrochloride, Aegle marmelos, Cashew nut tree gum, Sodium bicarbonate

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INTRODUCTION:

Ranitidine hydrochloride is a histamine H₂-receptor antagonist. It is widely prescribed in active duodenal ulcers, gastric ulcers, Zollinger-Ellison syndrome, gastroesophageal reflux disease, and erosive esophagitis. The recommended adult oral dosage of ranitidine is 150 mg twice daily or 300 mg once daily. The effective treatment of erosive esophagitis requires administration of 150 mg of ranitidine 4 times a day [1]. A conventional dose of 150 mg can inhibit gastric acid secretion up to 5 hours but not up to 10 hours. An alternative dose of 300 mg leads to plasma fluctuations; thus a sustained release dosage form of Ranitidine hydrochloride is desirable [2]. The short biological half-life of drug (2.5 ± 0.5 hours) also favors development of a sustained release formulation. Ranitidine hydrochloride is absorbed only in the initial part of the small intestine and has 50% absolute bioavailability [3]. All these factors highlight the need to develop sustained release dosage forms of Ranitidine hydrochloride. It is also reported that oral treatment of gastric disorders with an H₂- receptor antagonist like Ranitidine hydrochloride, used in combination with antacids, promotes local delivery of these drugs to the receptor of the parietal cell wall. Local delivery of these drugs also increases the stomach wall receptor site bioavailability and increases the efficacy of drugs to reduce acid secretion [4]. This principle may be applied for improving systemic as well as local delivery of Ranitidine hydrochloride, which would efficiently reduce gastric acid secretion.

The gastroretentive drug delivery system can be retained in the stomach and assist in improving the

oral sustained delivery of drugs. There is a need to investigate a number of indigenously available retardant materials to make the concept of controlled release drug delivery more viable for the drug industry at more economical way. In the present study, natural polymers such as Aegle marmelos gum and Cashew nut tree gum were selected for the preparation of floating tablets of Ranitidine hydrochloride. Sodium bicarbonate was used as gas generating agent. Tablets were prepared by wet granulation method using these polymers.

MATERIALS AND METHODS:

Ranitidine hydrochloride was obtained as a gratis sample from Hetero labs, Hyderabad. Aegle marmelos gum and Cashew nut tree gum were purchased from Yucca enterprises, Mumbai. PVP K 30, Isopropyl alcohol and Sodium bicarbonate were purchased from Qualigens fine chemicals, Mumbai. All other ingredients were of analytical grade.

Preparation of Ranitidine hydrochloride floating tablets

Ranitidine hydrochloride was mixed with required quantities of Cashew nut tree gum / Aegle marmelos gum, Sodium bicarbonate and Citric acid by geometric mixing. The tablets were formulated by employing wet granulation method using PVP K 30 as binder and isopropyl alcohol as granulating fluid. Magnesium stearate and talc were used as lubricant and glidant respectively. The final blend was compressed into tablets using 12 mm punches and corresponding dies on rotary tablet compression machine [6]. The composition of each formulation was given in Tables 1.

Table 1: Composition of Ranitidine hydrochloride floating tablets formulated with different natural polymers.

Ingredients	F ₁ (mg)	F ₂ (mg)	F ₃ (mg)	F ₄ (mg)	F ₅ (mg)	F ₆ (mg)
Ranitidine hydrochloride	150	150	150	150	150	150
Cashew nut tree gum	75	150	225			
Aegle marmelos gum				75	150	225
Micro crystalline cellulose	170	95	20	170	95	20
Sodium bicarbonate	50	50	50	50	50	50
Citric acid	25	25	25	25	25	25
Poly Vinyl Pyrrolidone	20	20	20	20	20	20
Magnesium stearate	5	5	5	5	5	5
Talc	5	5	5	5	5	5
Total weight	500	500	500	500	500	500

Evaluation Parameters

Flow properties of granules: The granules were evaluated for the following parameters [7].

a) Bulk density

5 gm of blend was weighed and transferred to a measuring cylinder. Then bulk volume was noted. Bulk density was calculated by using the following formula

$$\text{Bulk density} = \frac{\text{Mass of the powder}}{\text{Bulk volume}}$$

b) Tapped density

5 gm of blend was weighed, transferred to a measuring cylinder and subjected to 100 tapings. Then volume was noted as tapped volume. Tapped density was measured by using the following formula

$$\text{Tapped density} = \frac{\text{Mass of the powder}}{\text{Tapped volume}}$$

c) Carr's index

Carr's index was calculated by using the following formula

$$\text{Carr's index} = \frac{\text{Tapped density} - \text{Bulk density}}{\text{Tapped density}} \times 100$$

d) Hausner's ratio

Hausner's ratio was calculated by using the following formula

$$\text{Hausner's ratio} = \frac{\text{Tapped density}}{\text{Bulk density}}$$

e) Angle of repose

5 gm of blend was taken and poured into a hollow cylinder which was placed on a graph sheet. Then the cylinder was slowly lifted. Then height and diameter of the heap formed were noted down. The angle of repose (θ) was calculated by the formula

$$\text{Angle of repose, } \theta = \tan^{-1} \frac{h}{r}$$

Evaluation of Ranitidine hydrochloride floating tablets**a) Hardness:**

The hardness of the tablet was measured by Monsanto hardness tester. The lower plunger was placed in contact with the tablet and a zero reading was taken. The plunger was then forced against a spring by tuning a threaded bolt until the tablet fractured. As the spring was compressed a pointer rides along a gauge in the barrel to indicate the force [8]. The hardness was measured in terms of kg/cm^2 .

b) Weight variation:

Formulated tablets were tested for weight uniformity, 20 tablets were weighed collectively and individually. From the collective weight, average weight was calculated [8]. The percent weight variation was calculated by using the following formula.

$$\% \text{ Weight Variation} = \frac{\text{Average Weight} - \text{Average Weight}}{\text{Individual Weight}} \times 100$$

c) Friability:

The Roche friability test apparatus was used to determine the friability of the tablets. Thirteen pre-weighed tablets were placed in the apparatus and operated for 100 revolutions and then the tablets were reweighed. The percentage friability was calculated according to the following formula [8].

$$\text{Friability} = \frac{\text{Initial Weight} - \text{Final Weight}}{\text{Initial Weight}} \times 100$$

d) Swelling Index:

Formulated tablets were weighed individually (W_0) and placed separately in Petri dish containing 50 ml of 0.1N Hydrochloric acid. The Petri dishes were placed in an incubator maintained at $37 \pm 0.5^\circ\text{C}$. The tablets were removed from the petri dish, at predefined intervals of time and reweighed (W_t), and the % swelling index was calculated using the following formula [9]:

$$\% W_U = (W_t - W_0 / W_0) \times 100$$

Where:

W_U – Water uptake

W_t – Weight of tablet at time t

W_0 – Weight of tablet before immersion

Table 2: Micromeritic properties of granules of Ranitidine hydrochloride floating tablets formulated with different concentrations of natural polymers.

Formulation code	Angle of repose (°)	Bulk density (gm/cm ³)	Tapped density (gm/cm ³)	Carr's index (%)	Hausner's ratio
F ₁	26.72	0.520	0.616	15.58	1.184
F ₂	25.90	0.523	0.617	15.23	1.180
F ₃	25.41	0.527	0.619	14.86	1.175
F ₄	27.32	0.516	0.611	15.54	1.184
F ₅	26.94	0.519	0.613	15.49	1.183
F ₆	26.31	0.521	0.615	15.28	1.180

Table 3: Physical properties of Ranitidine hydrochloride floating tablets formulated with different concentrations of natural polymers.

Formulation	Hardness (kg/cm ²)	Weight variation (mg)	Friability (%)	Drug content (%)	Floating Lag time	Total floating time (hrs)
F ₁	4.5±0.021	501.32±0.24	0.40±0.010	100.14±0.13	2.25 min	>14
F ₂	4.7±0.025	500.65±0.28	0.34±0.018	99.78±0.15	2.12 min	>14
F ₃	4.8±0.032	499.83±0.39	0.25±0.024	99.56±0.11	1.23 min	>14
F ₄	4.3±0.011	500.23±0.13	0.45±0.015	99.54±0.12	2.36 min	>14
F ₅	4.5±0.022	501.12±0.18	0.36±0.021	99.68±0.11	2.17 min	>14
F ₆	4.7±0.016	499.66±0.23	0.28±0.013	99.73±0.17	1.52 min	>14

e) In vitro buoyancy study:

This test is characterized by floating lag time and total floating time. The test was performed using USP-Type II paddle apparatus using 900 ml of 0.1N Hydrochloric acid at paddle rotation of 100 rpm at 37 ± 0.5° C. The time required for tablet to rise to surface of dissolution medium and duration of time the tablet constantly float on dissolution medium was noted as floating lag time and total floating time [10].

f) Drug content:

20 tablets were weighed and powdered the powder weight equivalent to 150mg of Ranitidine hydrochloride was dissolved in 100ml of 0.1N Hydrochloric acid and filtered. 5ml of this was diluted to 50ml with water and drug content was estimated at 315 nm by UV spectrophotometer [11]

Table 4: *In vitro* drug release kinetic data of Ranitidine hydrochloride floating tablets formulated with different concentrations of natural polymers

Formulation	Correlation Coefficient Value				Release Rate Constant (mg/hr) k_0	Exponential Coefficient (n)	T ₅₀ (hr)	T ₉₀ (hr)
	Zero Order	First Order	Matrix	Peppas				
F ₁	0.9916	0.8293	0.9524	0.9963	15.33	0.7551	4.9	8.8
F ₂	0.9951	0.8058	0.9440	0.9964	13.70	0.7976	5.5	9.9
F ₃	0.9996	0.7313	0.9269	0.9998	12.70	0.9730	5.9	10.6
F ₄	0.9917	0.8358	0.9256	0.9966	16.12	0.7592	4.6	8.4
F ₅	0.9950	0.7892	0.9454	0.9968	14.4	0.8018	5.2	9.3
F ₆	0.9996	0.7801	0.9264	0.9998	13.06	0.9697	5.7	10.3

Table 5: Swelling index values of Ranitidine hydrochloride floating tablets formulated with different concentrations of natural polymers

Formulation code	Swelling index		
	Time in hours		
	after 1 hour	after 2 hours	after 8 hours
F ₁	54.34	78.93	149.24
F ₂	57.45	91.46	157.23
F ₃	60.12	98.56	171.39
F ₄	52.69	76.64	145.00
F ₅	55.24	89.89	154.00
F ₆	58.53	96.10	168.50

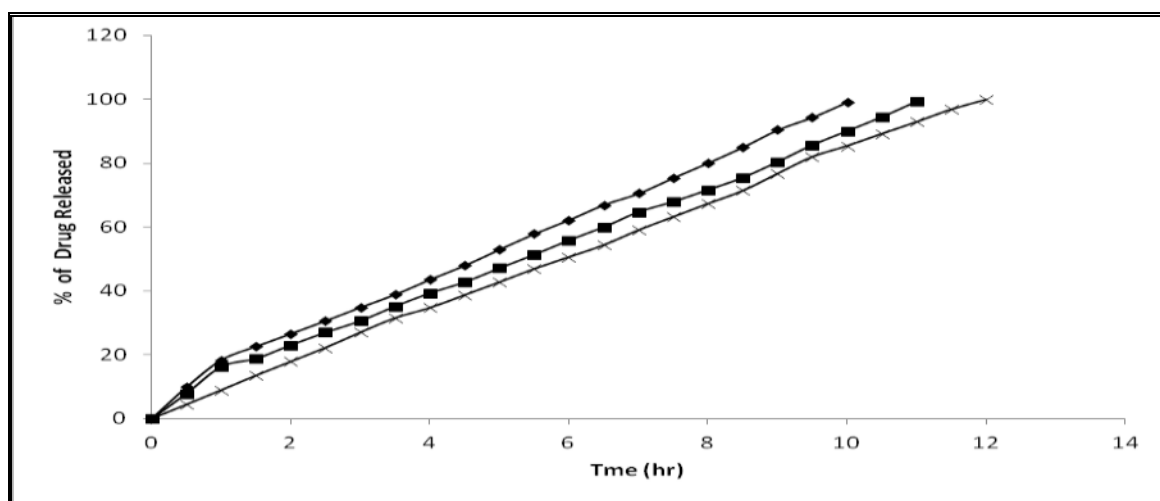


Fig 1: Comparative *in vitro* drug release profile of Ranitidine hydrochloride floating tablets formulated with different concentrations of Cashew nut tree gum

- (-♦-) Floating tablets formulated with drug and Cashew nut tree gum in 1:0.5 ratio
- (-■-) Floating tablets formulated with drug and Cashew nut tree gum in 1:1 ratio
- (-x-) Floating tablets formulated with drug and Cashew nut tree gum in 1:1.5 ratio

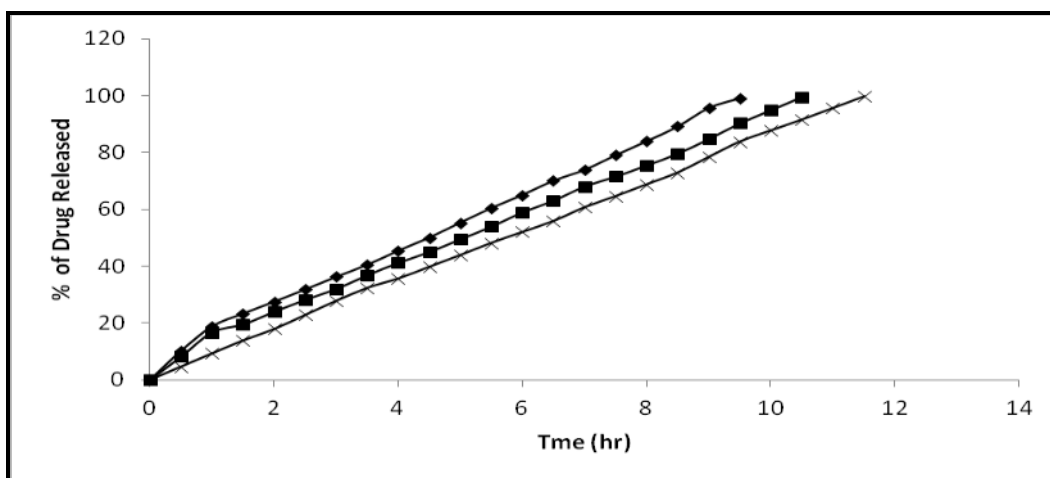


Fig 2: Comparative *in vitro* drug release profile of Ranitidine hydrochloride floating tablets formulated with different concentrations of Aegle marmelos gum

- (-♦-) Floating tablets formulated with drug and Aegle marmelos gum in 1:0.5 ratio
- (-■-) Floating tablets formulated with drug and Aegle marmelos gum in 1:1 ratio
- (-×-) Floating tablets formulated with drug and Aegle marmelos gum in 1:1.5 ratio

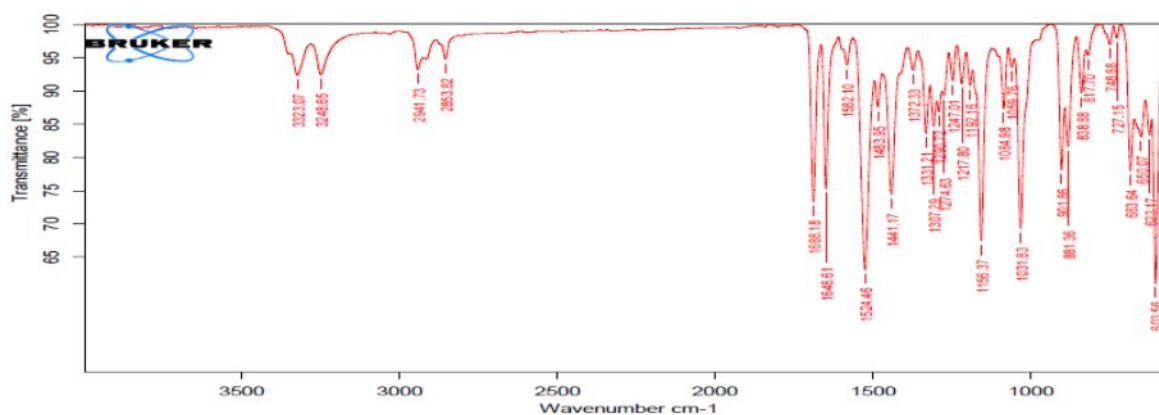


Fig 3 - FTIR spectrum of Ranitidine hydrochloride

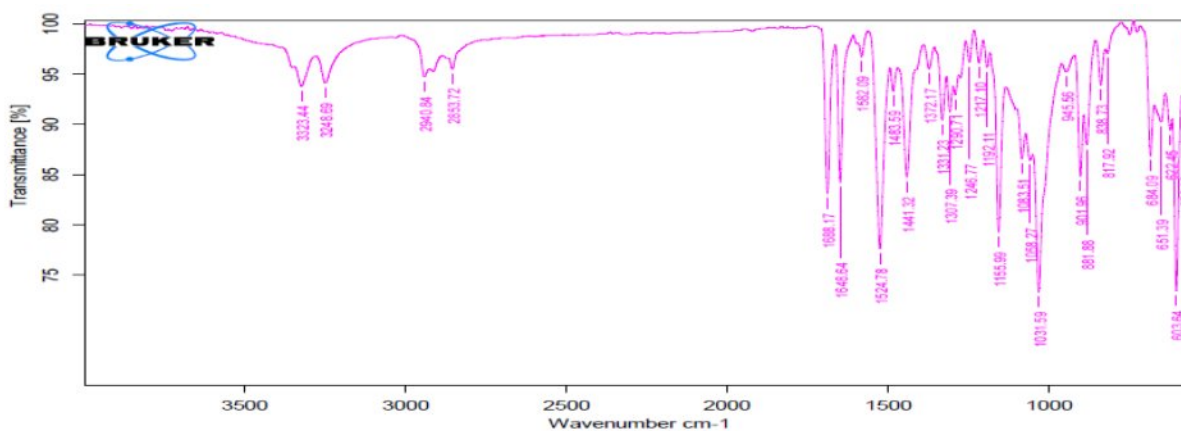


Fig 4- FTIR spectrum of Ranitidine hydrochloride floating tablet prepared with Cashew nut tree gum

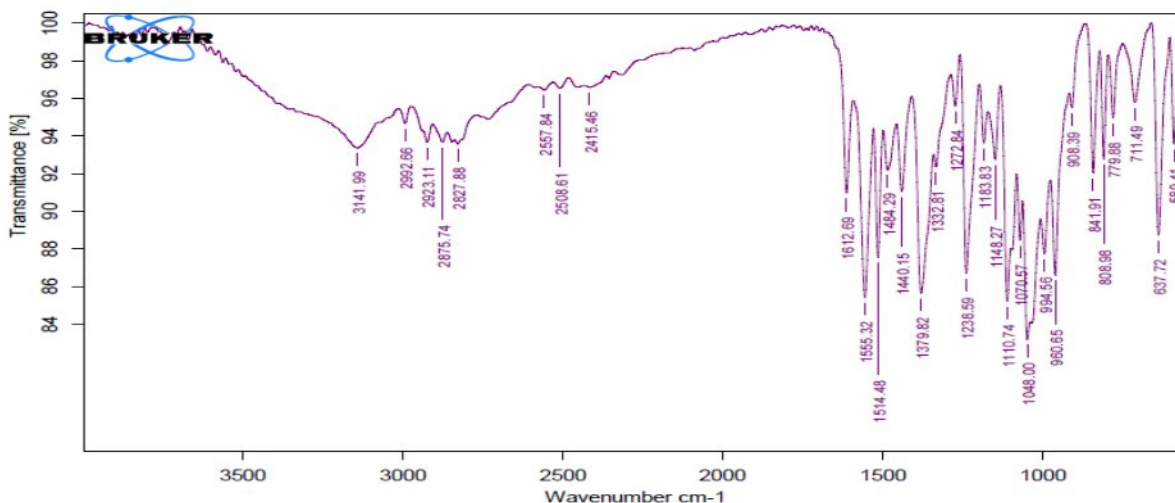


Fig 5 - FTIR spectrum of Ranitidine hydrochloride floating tablet prepared with Aegle marmelos gum

g) In vitro dissolution test:

The release of Ranitidine hydrochloride from the tablet was studied using USP-Type II paddle apparatus. Drug release profile was carried out in 900 ml of 0.1N Hydrochloric acid maintained at $37 \pm 0.5^\circ\text{C}$ temperatures at 100 rpm. 5 ml of samples were withdrawn at regular time intervals. The samples were replaced by its equivalent volume of dissolution medium and was filtered through $0.45 \mu\text{m}$ Whatman filter paper and analyzed at 315 nm by UV spectrophotometer [12].

Drug Excipient Compatibility Studies:

Fourier Transform Infrared (FTIR) Spectroscopy studies were used for the evaluation of physicochemical compatibility and interactions, which helps in the prediction of interaction of the drug with Cashew nut tree gum / Aegle marmelos gum used in tablet formulations[13].

Stability studies of optimized floating matrix tablets:

The optimized floating matrix tablets were separated in to two groups. Each group of formulations were placed separately in stability chamber which is maintained at $25 \pm 5^\circ\text{C}/60\% \text{ RH}$ and $40 \pm 5^\circ\text{C}/75\% \text{ RH}$ respectively for three months and every month the formulations from each group were subjected to dissolution studies and % drug release was calculated [14].

RESULTS AND DISCUSSION:

Floating tablets of Ranitidine hydrochloride were prepared by varying the concentration of Cashew nut tree gum (F_1 - F_3) and Aegle marmelos gum (F_4 - F_6). The formulated granules were evaluated for various flow properties. The bulk density for all the

formulations ranged from 0.516 to 0.527. The angle of repose for all the formulations was found to be in the range of $25^\circ 41' - 27^\circ 62'$. The Carr's index for all the formulations ranged from 15.58 – 14.86%. The value of bulk density indicates good packing characters. The value of angle of repose ($25^\circ - 30^\circ$) for all the formulations indicates good flow property. The value of Carr's index (10-16%) indicates free flowing material. The values of Hausner's ratio were found to be between 1.175-1.184. The powder blend with Hausner's ratio of 1.25 has good flow properties. So the values indicate that the granules had acceptable flow properties. The flow properties were shown in table 2.

Floating matrix tablets were evaluated for hardness and friability. The hardness was found to be in between 4.5 – 4.8 kg. The tablets satisfied friability requirement, as the % friability values were less than 1%. The drug content estimations showed values in the range of 99.54 to 100.14%, which reflects good uniformity in drug content among different formulations. All the tablets passed weight variation test as the % weight variation was within the Pharmacopoeia limits of $\pm 5\%$ of the weight. All the formulations showed values within the prescribed limits for tests like hardness, friability and weight variation which indicate that the prepared tablets are of standard quality.

All the tablets were formulated using sodium bicarbonate as effervescent agent. All the prepared formulations floated immediately after placing into the beaker and the floating was maintained more than 14 hrs. It was observed that the carbon dioxide generated from sodium bicarbonate in presence of dissolution medium (0.1N HCL) was trapped in the

polymer gel matrix formed by the hydration of polymer which decreases the density(<1) and makes the tablet buoyant. The results of various physical properties and *invitro* buoyancy studies were tabulated in table 3.

In vitro dissolution studies of all the formulations of floating matrix tablets were carried out in 0.1N HCl. The study was performed for 12 hrs and the cumulative drug release was calculated. All the formulations remained floating and intact throughout the dissolution studies. The formulations(F₁-F₃) containing Gum kondagogu showed decrease in drug release with increase in concentration of Gum kondagogu. The drug release from formulation F₃ containing drug and natural polymer in 1:1.5 ratio showed a maximum drug release at end of 12 hours. The dissolution profile for the formulations F₁- F₃ was shown in figure 1. The formulations(F₄-F₆) containing Aegle marmelos gum showed decrease in drug release with increase in concentration of Aegle marmelos gum. The drug release from formulation F₃ containing drug and natural polymer in 1:1.5 ratio showed a maximum drug release at end of 11.5 hours. The dissolution profile for the formulations F₄- F₆ was tabulated in table 6.11 and shown in figure 2.

To ascertain the mechanism of drug release, the dissolution data was analyzed by zero order, first order, and Higuchi and Peppas equations. The correlation coefficient values (r) revealed that the dissolution profiles followed Zero order kinetics and the mechanism of drug release was governed by Peppas model. The n values are found to be more than 0.5 ($n>0.5$) indicted that the drug release was predominantly controlled by non fickian diffusion. The in-vitro drug release kinetic data was shown in Table 4. The swelling index studies showed a gradual increase with increase in concentration of natural polymer and were shown in Table 5.

The characteristics peaks confirmed the structure of Ranitidine hydrochloride. The same peaks were also reported in all drug loaded matrix tablet. There were no change or shifting of the characteristic peaks in matrix tablets suggested that there was no significant drug polymer interaction which indicates the stable nature of the drug in all formulations. Drug release from optimized formulations before and after storage under varying conditions were evaluated periodically at the regular interval of every month. The drug release profiles of all the formulations did not change significantly after storage at $25\pm 2^\circ\text{C}/60\pm 5\%\text{RH}$ and $40\pm 2^\circ\text{C}/75\pm 5\%\text{RH}$ for a period of 3 months. There is no significant difference in the drug content and release rate constants. The results indicated that the drug release from the optimized formulations were found to be quite stable.

CONCLUSION:

From the above results, it is clearly evident that the *invitro* release of Ranitidine hydrochloride from the floating tablet was influenced by nature of natural polymer. Based on the release rate constant and % of drug release the formulations prepared with Cashew nut tree gum shown prolonged retarding nature compared with the formulations prepared with Aegle marmelos gum. Among all the formulations, F₃ formulation containing drug and Cashew nut tree gum in 1:1.5 ratio was found to be optimized formulations.

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